PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Fluid Film Thickness Detector and Tack Meter

We, THE RESEARCH ASSOCIATION FOR THE PAPER AND BOARD, PRINTING AND PACKAGING INDUSTRIES, formerly The Printing, Packaging and Allied Trades Research Association, a Company organised under the laws of Great Britain, of Randalls Road, Leatherhead, Surrey, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to apparatus for detecting changes in the thickness and tack of a fluid film adhering to a roller system. The word "fluid" as used herein is defined as material other than a gas or vapour, which material is capable of flowing or can be caused to flow, and is capable of forming a film on a roller, the film possessing light absorbing properties sufficient for correct function of the invention described below.

An object of this invention is to provide means for the simultaneously monitoring of the film thickness and tack of a fluid adhering to the roller system. The monitoring of detectable changes in film thickness is provided by an ink film monitor described in U.K. Patent Specification No. 1,140,107.

According to the present invention apparatus for monitoring (as defined herein) the film thickness and tack of a fluid (as defined above) adhering to a roller system comprises a film thickness monitor having a roller capable of being rotated by the roller system, means associated with the roller for monitoring the thickness of a fluid film adhering thereto, a movable member to one end of which is attached the roller, movement of the member being restrained by resilient means, and transducing means for providing a signal in response to said movement, the arrangement being such that the extent of said movement is proportional to the tack of the fluid adhering to said roller.

An example of the present invention when applied to a printing machine roller will now be described with reference to the drawings accompanying the Provisional Specification, in which:—

Figure 1 illustrates a front elevation, and

Figure 2 illustrates a side elevation of the assembly in contact with a roller system, and the drawings accompanying the Complete Specification, in which:—

Figure 3 is a fragmentary section of a modified form of the apparatus shown in Figure 1, and

Figure 4 is a circuit diagram of a Wheatstone bridge circuit.

Referring to Figures 1 and 2, reference numeral 1 denotes a printing machine roller. A transparent roller 2 forming part of the ink monitor 3, is shown in contact with the printing machine roller 1 in Figure 2. Ink is transferred to the transparent roller 2 causing a film of ink to adhere to its surface. A beam of light is projected onto the ink film surface from light source 9, and the light passing through the film is received by a photoelectric detector 4. The amount of light which reaches the detector 4 is related to the ink film thickness, and thereby the thickness of an ink film adhering to the roller system can be monitored. Monitoring is hereby defined as carrying out a method of obtaining a signal resulting from a detectable change e.g. in the thickness or tack of a film adhering to the roller referred to in the claims. A full description of an ink film monitor working on the above principle is described in U. K. Patent Specification No. 1,140,107. The latter patent specification also describes use of the

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ink film thickness monitor for controlling the flow of ink to a roller system.

The ink film monitor assembly 3 is attached to a hollow member 8 which is pivoted approximately about its centre by the pivots 10. A colour filter 6 is attached to the end of the member 8 to filter the light from a light source 9 housed in a cavity 11. The member 8 contains a channel 12 such that light from the light source 9 may be transmitted to the transparent roller 2, and a reference photocell 13 as shown in Figure 2.

The end 14 of the member 8 is arranged to be in contact with one end of a transducer 15. Relative movement of the end 14 in response to movement of the member 8 about its pivots 10 is detected by the part 16 of the transducer 15. The transducer 15 is capable of converting mechanical movement into electrical signals to be supplied to an indicating device which displays the output of the transducer.

Movement of the member 8 about its pivots 10 depends on the tack of the ink adhering to the roller system and the relative movement of the rollers. Due to the tack of the ink, the ink film monitor end of the member 8 will tend to be moved downwards as a result of the tangential forces between the transparent roller 2 and the printing machine roller 1, caused by the rotational motion of the printing machine roller 1. The extent to which the member 8 is displaced about its pivots 10 will depend on the tangential forces between the rollers 1 and 2. Since the frictional forces due to roller contact are substantially constant, the variations in displacement of the end 14 of member 8, are due to changes in the tack of the ink.

The ink film monitor 3, the member 8, and the transducer 15 are mounted in a suitable frame 17 which supplies support for the pivots 10. The transducer is shown attached to a cross member 18 of the frame 17. The turning motion of the member 8 is restrained by a proving ring 19. The restraining forces applied by the proving ring are due to compression of the ring about a diameter.

The proving ring 19 is pivoted about the lamp cavity 11 at pivot 20, and is attached to the member 8 at a location 21 just below the lamp cavity 11.

The member 8 contains light shields 5, and heat filters 7 as shown in Figure 2.

Reference numeral 11 indicates a dash-pot arranged to damp the relative motion of the end 14 of the member 8 which moves in response to the tack of the ink. However, the dash-pot is not absolutely necessary, and may be dispensed with.

The complete assembly may be supported by the bracket 24, which contains the slot 23 to enable suitable attachment of the assembly relative to the roller system. The whole apparatus pivots about the slot 23 so that the normal force between the rollers 1 and 2, is the resolved part of the weight of the apparatus. Means are provided so that movement of the bracket 24 along the axis of the roller is eliminated, while free rotation about the slot 23 is allowed.

In one alternative embodiment of the invention the transducer 15 is dispensed with, and strain gauges are attached to the inner side of the proving ring 19. Since the ring 19 distorts in response to the displacement of the end 14 of the member 8, the strain gauges respond accordingly to provide a measure of the tack of the ink. For example, four strain gauges may be attached at the curved inner surface of the ring 19 each being located at each end of two diameters at right angles to across the ring. The centres of each gauge would then be spaced substantially at 90° intervals around the ring. A first pair of gauges may be mounted in vertical axis and a second pair in the horizontal axis of the ring 19. If the ring 19 is then compressed in the vertical axis, the first pair of gauges would be in tension, and the second pair in compression.

Each of the strain gauges may form one arm of a Wheatstone bridge. The out-of-balance signal across the bridge may be used as a measure of the deflection of the end 14 of the member 8, and hence as a measure of the tack.

In a second and more practical embodiment, two strain gauges are attached to the inner side of the proving ring 19, and two strain gauges are attached to the frame 17. Figure 3 illustrates an embodiment in which two strain gauges 30 and 31 are attached to the ring 19, and disposed at the ends of its horizontal diameter, and two strain gauges 32 and 33 are attached to the sides of the frame 17. Strain gauges 30 and 31 respond to any distortion of the ring 19, whilst strain gauges 32 and 33 which are not strained, provide a reference signal. By locating the strain gauges as shown in Figure 3, the difficulties encountered when the strain gauges are attached at 90° intervals around the ring 19 are avoided.

In the second embodiment, each of the strain gauges forms one arm of a Wheatstone bridge, the out-of-balance signal being used to drive indicating means for measuring the tack of the ink.

In a further modification, however, a thermistor is embedded in the transparent roller 2, which provides a means of temperature compensation of the output of the strain gauges. In this instance, the strain gauges from the arms of a Wheatstone bridge, and the thermistor is connected in series with a fixed resistance across the output connections of the bridge. This circuit is described below in more detail, with reference to Figure 4.

The thermistor is located in a groove in the transparent roller 2, and is overlaid with the material of which the roller is made. For example, when the roller is made from Perspex (Registered Trade Mark) the thermistor is overlaid with this material, and the roller surface is machined to its original cylindrical form. Since the thermistor rotates with the roller 2, it is necessary to employ some means for connecting the rotating leads of the thermistor to the stationary leads of the bridge circuit. Any suitable means may be used, for example, conventional slip-rings and brushes, and in a preferred arrangement the thermistor leads are connected to wipers that rotate together with the roller 2, and which make electrical contact with the slip-rings fixed relative the axis of the roller 2.

Figure 4 illustrates a circuit diagram of a Wheatstone bridge measuring circuit for use with the strain gauges. The strain gauges 30 to 33 form the arms of the bridge. Resistance 37 is included across the ends of 31 and 33 to facilitate balancing of the Wheatstone bridge. The thermistor 34 is connected in series with a fixed resistor 35 across the output connections to the bridge. An indicating means, such as a volt-meter 36 is connected across the fixed resistor 35. If the temperature at the roller 2 fluctuates, the resistance of the thermistor 34 changes accordingly. Thus, since the fixed resistor 35 and the thermistor act as a potential divider, and the out-of-balance signal from the bridge is applied thereto, the voltage measured by the volt-meter 36 is proportional to the tack, and can be arranged to be independent of the temperature of the ink adhering to the roller 2. For example, if the temperature of the ink rises, its tack decreases, and the out-of-balance voltage e of the bridge decreases. Since, the voltage v developed across the fixed resistor 35 is given by:—

$$v = \frac{Re}{R+T}$$

where R is the value of the fixed resistor 35, and T is the resistance of the thermistor 34, the change in T can be arranged to compensate substantially for the change in e.

Under normal operating conditions, the output of the photoelectric detector 4, and the output voltage developed across the fixed resistor 35, are continuously recorded by suitable recording means. Changes in the tack of the ink are primarily caused by changes in the ink film thickness, the water content of the ink, and the temperature of the ink. Of these primary variables, changes in the water content and the thickness of the ink film are most important, since a change in ink temperature does not normally adversely affect the printing process. However, since a change in temperature affects the tack of the ink, but does not appreciably affect the ink film thickness, the temperature compensation means including the thermistor 34 described above, does not allow a change in the indication of the tack of the ink when only the temperature of the ink changes. Thus, the temperature compensation means ensures that major changes in the tack of the ink are only indicated as a result of changes in the water content and/or the thickness of the ink film.

Whilst the foregoing describes apparatus which is used as a separate unit in conjunction with a printing machine, it may also be combined with the printing machine as an integral fixture. For example, in most printing machines of the type suitable for use with the present invention, an idler roller is provided which bears against one of the ink rollers, so as to spread the ink thereon into a more even layer. Such an idler roller may be replaced by the transparent roller of the present invention.

In a particular arrangement, the idler roller needs to be of a special construction, for example a hollow metal roller having a transparent insert around part of its cylindrical surface. The roller would be mounted on a stationary spindle which is constrained from rotary motion by suitably designed resilient supports attached to the side frame of the printing machine. The resilient supports are then provided with transducers for measuring the tangential forces between the idler roller and its contacting roller. An optical system is mounted on the stationary spindle to monitor ink film thickness by directing a light beam through the transparent insert on a photoelectric cell mounted on the spindle. A thermistor is embedded in the wall of the roller, as previously described, for temperature compensation.

It will also be apparent that the apparatus described herein may be used for the measurement of tack and film thickness of fluids other than ink, which are capable of adhering to a roller system.

WHAT WE CLAIM IS:—

1. Apparatus for monitoring (as herein defined) the film thickness and tack of a fluid (as herein defined) adhering to a roller system comprising a film thickness monitor having a roller capable of being rotated by the roller system, means associated with the roller for monitoring the thickness of a fluid film adhering thereto, a movable member to one end of which is attached the roller, movement of the member being restrained by resilient means, and transducing means for providing a signal in response to said movement, the arrangement being such that the extent of said movement is proportional to the tack of the fluid adhering to said roller.

2. Apparatus as claimed in claim 1, in

which the roller is separate from the roller system and is capable of being moved into contact with one of the rollers of the roller system.

3. Apparatus as claimed in claim 1 or claim 2 in which the movable member is a pivoted arm capable of arcuate movement about its pivots.

4. Apparatus as claimed in claim 3 in which the pivoted arm is supported by a frame carrying bearings for said pivots, and the resilient means is a circular ring, the ring being pivotally supported by the frame and being attached to the pivoted arm at a point diametrically opposite the pivotal support of the ring such that, when the arm moves arcuately about its pivots, the ring is distorted and thereby restrains the movement of the arm by the elastic forces set up in the ring.

5. Apparatus as claimed in claim 3 or claim 4 in which the transducing means is a transducer having a movable element in contact with that end of the pivoted arm not attached to the roller, such that arcuate movement of said end of the arm is detected by the movable element, and converted by the transducer into an electrical signal.

6. Apparatus as claimed in claim 4 in which the transducing means comprises at least one strain gauge attached to the ring, the resistance of the strain gauge varying when the ring is distorted.

7. Apparatus as claimed in claim 6 in which four strain gauges are attached at 90° intervals around the ring, two of said gauges being located diametrically opposite each other across the horizontal diameter of the ring, as the resistance of each strain gauge varying when the ring is distorted.

8. Apparatus as claimed in claim 6 in which two strain gauges are attached to the ring, and two strain gauges are attached to the frame, the resistance of each strain gauge attached to the ring varying when the ring is distorted, and the strain gauges attached to the frame being used as reference resistances in relation to said variable resistances.

9. Apparatus as claimed in claim 7 or claim 8, in which each of the strain gauges forms one arm of a Wheatstone bridge, the out-of-balance signal being proportional to the movement of the pivoted arm and hence the tack of the fluid adhering to the roller.

10. Apparatus as claimed in claim 9 in which a voltage or current driven indicator is connected across the output of the bridge.

11. Apparatus as claimed in any preceding claim in which a temperature responsive element is associated with the roller and capable of producing a signal which is related to the temperature of the fluid adhering to the roller.

12. Apparatus as claimed in claim 11 in which the second signal is combined with the signal derived from the transducing means so as to compensate the latter signal for variations in the temperature of the fluid adhering to the roller.

13. Apparatus as claimed in claim 11 or claim 12 in which the temperature responsive element is a thermistor embedded in the cylindrical walls of the roller, means being provided for electrically connecting the rotating leads of the thermistor to fixed leads, and the thermistor being located in a position so as not to interfere with the function of the film thickness detector.

14. Apparatus as claimed in claim 13 when claimed 11 is appended to claim 7 or claim 8 in which each of the strain gauges form one arm of a Wheatstone bridge, and a fixed resistor is connected in series with the thermistor, across the output terminals of the bridge, a voltage indicating means being connected across the fixed resistor, the arrangement being such that the output signal from the bridge decreases if the tack of the fluid adhering to the roller decreases, and if the tack of said fluid decreases as a result of a change in its temperature, the subsequent change in the resistance of the thermistor substantially compensates for the change in the output signal from the bridge, no indication of a change in the tack of the fluid being given by the indicating means when the temperature of the fluid alone varies.

15. Apparatus as claimed in any preceding claim in which the film thickness monitor is of the type comprising a transparent roller capable of rotating in contact with the roller system, a first photoelectric cell disposed within the transparent roller, a light source arranged to illuminate the first photocell through the surface of the transparent roller, a second photoelectric cell arranged to receive, from the light source, light whose intensity varies, in use only as the intensity of the light source varies, means for deriving a signal from the output of the first and second photoelectric cells in combination either to monitor the thickness of the fluid film adhering to the transparent roller, or to control the flow of fluid to the roller system, which fluid forms the fluid film.

16. Apparatus as claimed in claim 1, in which said roller is one of the rollers of the roller system.

17. Apparatus as claimed in claim 16 in which the said roller is a hollow metal roller having a section along its length capable of transmitting light, the roller being rotatably mounted on a fixed spindle carried in a resilient support attached to a side frame of the roller system, transducing means being attached to said resilient supports for measuring the movement of the roller in response to the tack of the fluid adhering thereto, and an optical system including a photoelectric cell mounted on the spindle to monitor the changes in the thickness of the fluid film ad-

hering to said light transmissive section of the roller, by directing light through said section and the fluid film on the photoelectric cell.

18. Apparatus as claimed in claim 17 including the temperature responsive element described in any one of claims 11 to 13.

19. Apparatus as claimed in claim 16 including the film thickness monitor described in claim 15.

20. Apparatus as claimed in any preceding claim when used in conjunction with the roller system ofa printing press, said fluid being ink used in the printing process.

21. Apparatus for monitoring the film thickness and tack of a fluid adhering to a roller system substantially as herein described with reference to the drawings accompanying the Provisional Specification.

22. Apparatus for monitoring the film thickness and tack of a fluid adhering to a roller system substantially as herein described with reference to the drawings accompanying the Complete Specification.

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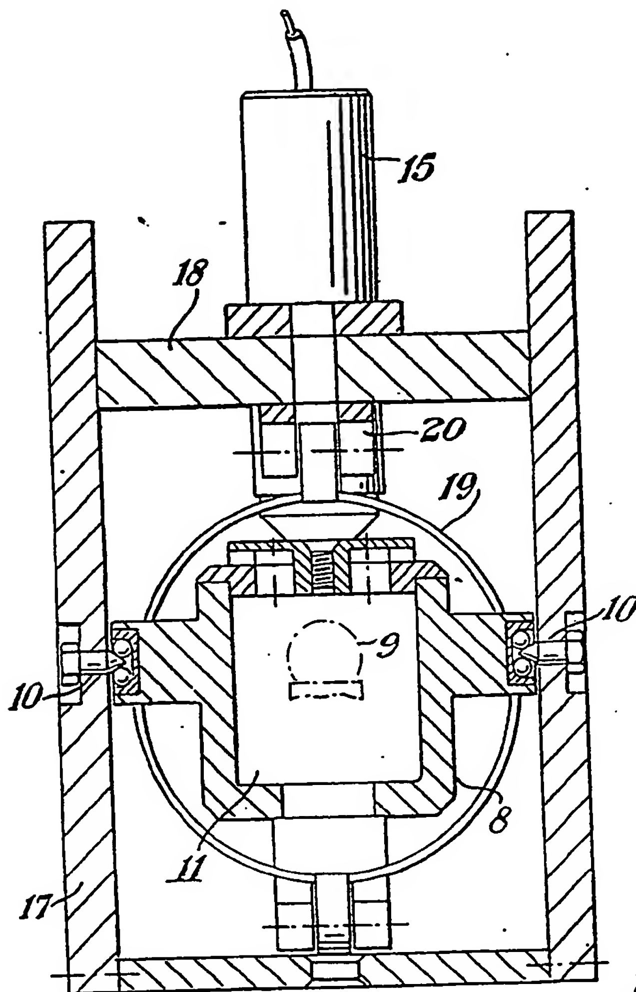


Fig.1.

1150527 PROVISIONAL SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheets 1 & 2

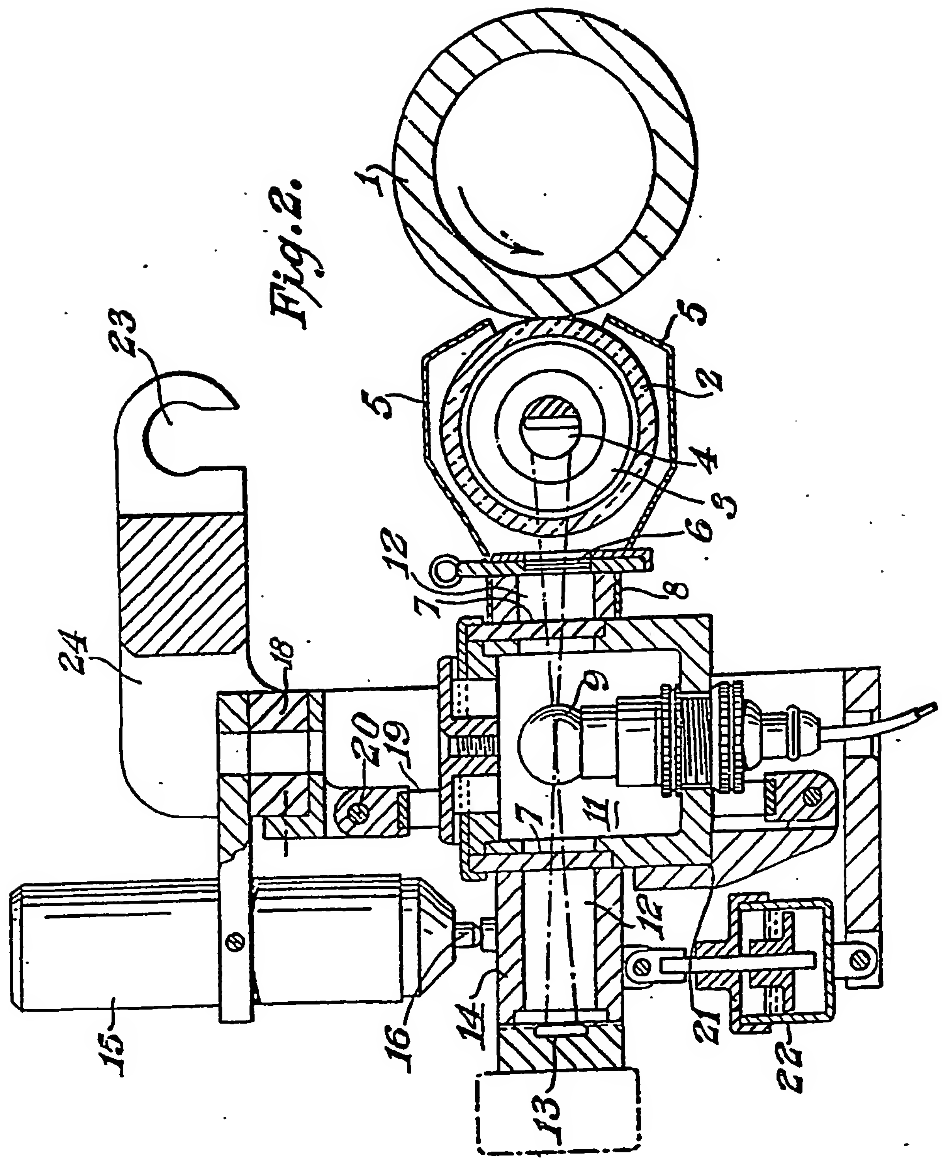


Fig.2.

g.1.

1150527 PROVISIONAL SPECIFICATION
2 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheets 1 & 2

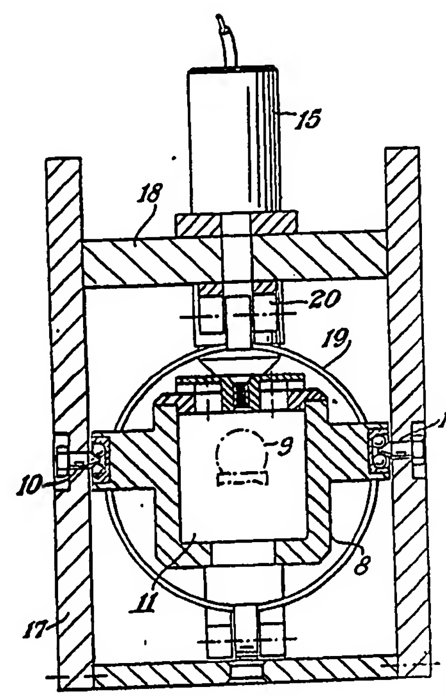


Fig.1.

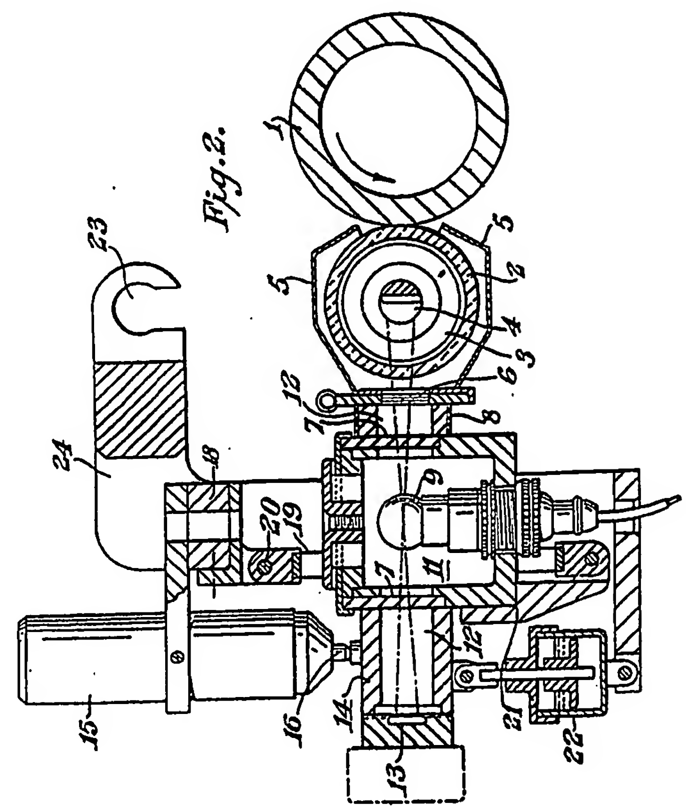
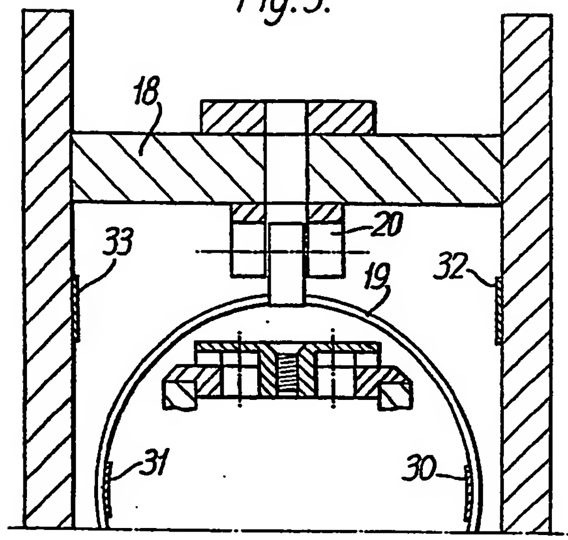


Fig.2.

1150527 COMPLETE SPECIFICATION

1 SHEET This drawing is a reproduction of the Original on a reduced scale

Fig. 3.



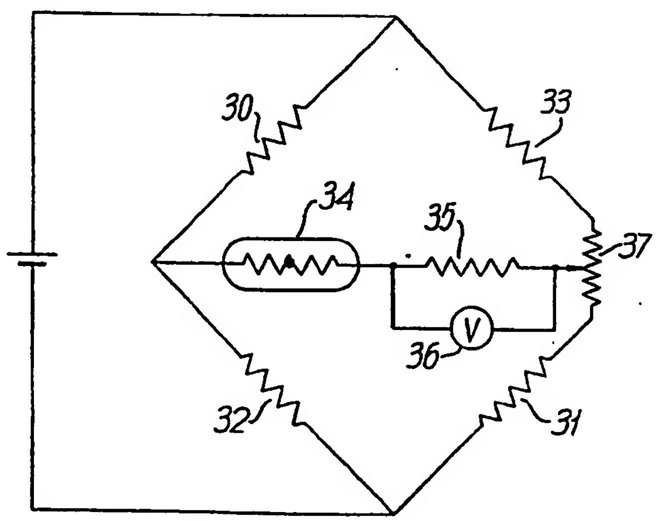


Fig. 4.